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AUTHOR Holmes, Betty C.
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ABSTRACT

A study was conducted to gain insight into the question answering abilities of good and poor readers by comparing how well they answered questions when their prior knowledge was at two different levels (high, low) and in four different states. These states of prior knowledge consisted of the ways in which answers to the questions were stored in the reader's memory before a text was read--accurately, inaccurately, incompletely, or not at all. Subjects were 56 fifth-grade students of equivalent intelligence but varying in reading ability and level of prior knowledge. To identify the prior knowledge level of the students, an experimenter-designed assessment instrument--intended to tap all information from the passages that was required to answer experimenter-designed comprehension questions--was administered. The subjects read passages that had been prepared on two different topics and at three different levels of difficulty, and then responded to the comprehension questions concerning the passages. The results showed that the poor readers did not use a large store of background knowledge to the same advantage as did the good readers. The poor readers' prior knowledge seemed to help only in answering verbatim and paraphrased questions when the answers were already stored accurately. The poor readers were not using their prior knowledge for in-depth processing of text or for completing a framework with new information. (FL)

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Dr. Betty C. Holmes
Assistant Professor in Education
and Reading
The Capitol Campus
The Pennsylvania State University
Middletown, PA 17057

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THE EFFECT OF THE STATES OF PRIOR KNOWLEDGE ON QUESTION ANSWERING

Dr. Betty C. Holmes

Although the literature indicates that prior knowledge facilitates the comprehension of average readers (Ausubel and Fitzgerald, 1961; Pearson, Hansen, and Gordon, 1979; Langer and Nicolich, 1980), it is not clear why this facilitation occurs nor whether the same effect is realized by poor readers. One way in which prior knowledge may aid in question answering is that the answers may already be stored in memory before reading thus mere recall is required rather than reasoning (Tuinman, 1979). If this is the case, poor readers may simply be persons with an inferior store of background information, or persons who ignore their existing knowledge.

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Secondly, readers are thought to use their prior knowledge to build a framework on to which new information can be added (Anderson, Reynolds, Schallert, and Goetz, 1977; Ausubel, 1968). Poor readers may fail to use their existing knowledge as a framework to learn new information from the text and to correct a misinformation in their knowledge store.

The literature also indicates that prior knowledge may facilitate question answering by increasing the depth of processing (Craik and Lockhart, 1972; Schallert, 1976). Average readers with high prior knowledge have scored significantly better than readers with low prior knowledge on implicit questions but not explicit questions (Pearson, et al. 1979). Thus, the background information may have increased the readers' ability to process the more difficult type of questions. In the Pearson, et al. study, the explicit questions were verbatim questions asking for one fact or idea and the implicit questions required the reader to combine an idea from the text with information from their background knowledge. Whether the prior knowledge would indicate depth of processing using textually implicit and paraphrase questions is not known. It is also not known if high prior knowledge would benefit poor readers in answering these different types of questions.

Purpose

The purpose of this study was to gain greater insight into the question answering of good and poor readers by comparing how well they answer questions when their prior knowledge is at two different

levels and in four different states. The states of prior knowledge were how the answers to the questions were stored in the reader's memory before the text was read. The answers were stored accurately, inaccurately, incompletely, or not at all (void state).

Methodology

Subjects

Fifty-six fifth-grade students with equivalent I.Q.'s but varying in reading ability and level of prior knowledge participated in the study. High ability fifth-grade subjects scored between the 6.0 and 7.0 grade equivalent levels on both the Vocabulary and Comprehension subtests of the California Achievement Test. The low ability subjects scored between the 3.0 and 4.0 grade equivalent levels on the same two reading subtests. Subjects were considered to have high prior knowledge if they gave fifty or more accurate facts on each of two selected topics (combined mean for good readers $\overline{X}$=113, poor readers $\overline{X}$=109). Subjects were considered to have low prior knowledge if they produced thirty-five or fewer accurate facts for each topic (combined mean for good readers $\overline{X}$=68, poor readers $\overline{X}$=65).

Materials

Experimenter-designed prior knowledge assessment instrument. In order to identify each subject as high or low in prior knowledge on the selected topics, an experimenter-designed prior knowledge assessment instrument was constructed. It consisted of 185 open-ended (wh) and forced-choice questions designed to tap all information from the passages required to answer the experimenter-designed comprehension

questions and most of the additional information which was contained in the passages but not required for answering the comprehension questions. This additional information was assessed because the more facts mentioned in the passage and already present in prior knowledge, the more attention the reader may have to focus on new facts in the passage thus promoting learning and remembering.

Passages. Two expository passages of ten paragraphs each were written on each of the selected topics. One of the passages for each topic was written at approximately the 3.0 grade level and the other was written at the 6.0 grade level as estimated by the Harris-Jacobson Readability Formula. Furthermore, each paragraph within the easier passage had a readability level between 3.0 and 4.0, and each paragraph within the more difficult passage had a readability level between 6.0 and 7.0 as estimated by the Harris-Jacobson Readability Formula. Three levels of difficulty were selected so that the groups of comprehenders could be compared reading at their appropriate reading achievement level. The 3.0 level passage represented the reading achievement level of the poor fifth-grade readers. The 6.0 level represented the minimum achievement level of the good fifth-grade readers.

Experimenter-designed comprehension questions. Four questions were written by the experimenter for each paragraph. There was one question from each of the following four types: (a) a one-idea verbatim text explicit, (b) a one-idea paraphrase, (c) a two-idea verbatim, and (d) a text implicit. The answers to the two types of verbatim questions were stated directly in the text in one sentence. The answers to the paraphrase questions were stated in the text in one sentence but required

understanding and an inference. The answers to the text implicit questions were indirectly stated in the text and required the combining of related ideas in two sentences.

The types of questions originated from the comprehension classification system devised by Pearson and Johnson (1978). The literature on post questions suggests that readers perform better on explicit questions than implicit questions. The explicit questions are generally like those defined in Bormuth (1969) and represented by this study's one-idea verbatim. Typical text explicit and text implicit questions seem to differ in at least the following three ways: (a) number of ideas involved (explicit -- one; implicit -- two), (b) degree of cognitive processing required (explicit -- rote memory; implicit -- understanding and inferencing); and (c) number of sentences involved (explicit -- one; implicit -- two or more). By including the other two types of questions, it was hoped that greater insight into readers' difficulty with text implicit questions could be gained. The same questions were used for both levels of difficulty for each topic. However, when necessary, the wording for the verbatim questions was changed to coincide with the wording of the passage.

Scoring of responses. The responses to the experimenter designed prior knowledge assessment instrument were first divided into facts. A fact represented a statement consisting of one subject and/or one verb and/or one object and/or descriptor or descriptive phrase. Examples of single facts are "They hiss" and "Snakes have dry skin." An example of two facts in a response is "They have two fangs in front and some in back." In the case of yes-no questions, the answer "yes"

or "no" was counted as a fact. The facts were then scored as either correct or incorrect using non-fiction books on the topics and articles in World Book Encyclopedia.

The responses to the comprehension questions were scored using the following two-point scale: two points = a correct answer; one point = a partially correct answer; and zero points = an incorrect answer or no response. The following are examples of the scoring:

Question: In what ways is the oil from sharks used by man?

Responses:

(a) to make furniture polish and paint = two points

(b) to shine wood = one point

(c) to cook food = zero points

(d) I don't know = zero points

Correctness was determined by a consensus of non-fiction books on the topics and World Book Encyclopedia.

Two persons knowledgeable on the selected topics scored random samples of three prior knowledge assessments and three comprehension question protocols from each of the four groups of subjects. This number represented approximately 20 percent of the prior knowledge assessments and comprehension question protocols. The inter-rater reliability for number of correct facts was .95 and for correctness of comprehension response was .98.

Determining States of Prior Knowledge. In order to better understand the question answering process of the different groups of readers, a qualitative dimension of prior knowledge states was also included. States of prior knowledge were defined as accurate, inaccurate, incomplete

and void (missing) information. For each post question, each subject's prior knowledge assessment protocol was checked to determine if before reading the passage the subject already had the correct answer stored in memory. If the correct information was found on the protocol, then the score received on that particular question was placed in the accurate condition. If the correct answer was not found on the protocol, then the score received on that particular question was placed in the accurate condition. If the correct answer was not found on the protocol, then the experimenter decided on the basis of the information available whether the subject's prior knowledge on that question was inaccurate, incomplete, or missing. Thus, for each of the 50 post questions, the information elicited from each subject for the related questions of the prior knowledge assessment was categorized as being in either the accurate, inaccurate, incomplete, or void condition. This categorization permitted a more in-depth analysis of the readers' question answering (e.g., the degree to which the readers used their prior knowledge, modified their incorrect information, and assimilated incomplete and missing information).

Design. The design of the study was a $2^3 \times 4^2$ factorial. The between subject factors were ability (good, poor), level of prior knowledge (high, low), and block (passage on sharks, passage on snakes). The within subject factors were types of questions (one-idea verbatim, paraphrase, two-ideas verbatim, text implicit) and states of prior knowledge (accurate, inaccurate, incomplete, void).

Results and Discussion

Overall Analyses

Significant main effects were found for all the factors except block (ability F=25.77, level F=11.35, question type F=40.99, state F=52.84). The main effect for ability gives the appearance that even when the comprehension of good and poor readers was compared with each group reading on their appropriate instructional level, the good readers tended to score better. However, an interesting pattern emerged when the results of the interaction of ability by level of prior knowledge was examined.

Level of Prior Knowledge

Analyses comparing the two ability groups by levels of prior knowledge revealed that when each group read on their instructional level, the good readers with high prior knowledge scored significantly better than the other three groups (ability X level, F=7.29, $p<.01$). However, there were no significant differences among the other three groups (see Figure 1). This finding suggests that in pursuing new

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Insert Figure One About Here

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topics, poor readers may perform as well as good readers. Good readers without their superior store of prior knowledge and without their advantage of word recognition may be little better than poor readers in answering reading comprehension questions. On the otherhand, when good and poor readers are both knowledgeable on a topic, the good

readers may be better able to use their prior information to answer questions.

States of Prior Knowledge

To examine whether there were significant differences between the two groups of readers answering questions from the four states of knowledge, simple main effects tests were conducted. The data consisted of percentages of points received for correct answers to number of possible points that could be received. These percentages were converted to arcsin transformations for the analysis. The good readers had significantly higher arcsin scores than the poor readers when the answers were categorized in any of the states (accurate $F=7.16$; incomplete $F=17.62$; void $F=28.35$, $p<.01$; inaccurate $F=4.74$, $p<.05$). Good

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Insert Figure Two About Here

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readers were thus superior to the poor readers in learning new information from the text and in correcting previous misinformation while reading the text. More surprising was that even when poor readers knew the necessary information for answering questions prior to reading the text, they did not answer the questions as well as did the good readers.

When the scores for the groups of readers were divided according to level of prior knowledge, another interesting pattern emerged. The good readers with high levels of prior knowledge continued to be significantly better than the poor readers with high levels of prior knowledge in answering questions from all states of prior knowledge (accurate $F=8.36$; incomplete $F=17.34$; void $F=28.13$, $p<.01$; inaccurate $F=5.83$,

$p<.05$). However, the good readers with low levels of prior knowledge were not significantly better than the poor readers with low levels of prior knowledge in any of the states of prior knowledge.

Insert Figures Three through Six About Here

Thus, it appears that good readers with high levels of prior knowledge use that knowledge to greater advantage than do poor readers.

Types of Questions

Comparisons were also conducted for the interaction of groups by question type (see Figure 7). The good readers were significantly better in answering every type of question except the verbatim two-ideas. As with the states of prior knowledge, there were significant differences between the groups of good and poor readers with high prior knowledge on all the question types. Meanwhile, comparisons between the good and poor readers with low prior knowledge yielded no significant differences.

Insert Figure Seven About Here

A clearer picture of children's question answering was revealed by comparing good and poor readers' performance on different types of questions when their information before reading the text was in each of the states of prior knowledge. When both groups of readers had the accurate answers already stored, there were no significant differences between the groups on the verbatim or paraphrase questions. However,

good readers were significantly better than the poor readers in answering the text implicit questions ($F=11.45$, $p<.01$). It had been thought by some researchers that the ability to answer inferential questions might be determined by the reader knowing the correct facts (Omansen,

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Insert Figures Eight through Eleven About Here

Warren, and Trabasso, 1979). However, even when the poor readers had the prerequisite information, they were significantly worse in answering the text implicit questions than were the good readers. The wide discrepancy between the poor readers' scores on the text implicit and the other three types of questions suggests that text implicit questions may be difficult for poor readers because they must go beyond the sentence boundary and/or the deeper level of reasoning required for that type of question.

In the inaccurate condition, scores for both good and poor readers dropped significantly. This finding suggests a similar progression for question answering to the one found by Hilyard regarding inferences. She found that children first learned to make inferences with their world knowledge, then with new information, and finally with contradictory information.

The poor readers also performed poorly in the void condition. They scored significantly worse on all four types of questions (one idea verbatim $F=9.64$, paraphrase $F=8.57$, text implicit $F=8.52$, $p<01$; two idea verbatim $F=5.12$, $p<.05$). As in the other conditions, both groups had the most difficulty with the text implicit questions.

Apparently, learning new information and trying to make an inference at the same time is a quite difficult task. By examining the data in Table One, one can see that the good readers with high prior knowledge answered more questions correctly than the good readers with low prior knowledge in the accurate and void conditions. On the other hand, the poor readers with high prior knowledge scored more points in the

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Insert Table One About Here

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accurate condition but fewer points in the void condition than did the poor readers with low prior knowledge. Only on the verbatim questions in the accurate condition did the good readers with high prior knowledge appear equal to the good readers with high prior knowledge. Differences are particularly noticeable on the text implicit questions. These findings suggest that high levels of prior knowledge help good readers not only when they already have the correct information but also in learning new information. In contrast, poor readers seem to be helped by prior knowledge only because they already have more correct answers stored in memory.

Conclusions

To summarize, the poor readers did not seem to use a large store of background knowledge to the same advantage as the good readers. The poor readers' high level of background information seemed to help only in answering verbatim and paraphrase questions when the answers were already stored accurately. Areas not being facilitated by high

prior knowledge to the extent of good readers were inferencing (even when they had accurate data before reading), modifying incorrect information, and learning new information. Poor readers, unlike good readers, are apparently not using their background knowledge for more in-depth processing (e.g., text implicit questions) and are not using it for completing a framework with new information.

Research evidencing the effect of activating readers' background knowledge prior to reading (Miller, 1980) is thus probably facilitating the question answering in one of these areas. Perhaps the activation makes the poor readers more aware of what they know and don't know so that they are alert to contradictory and new information. Previous research in metacognition has indicated that good readers are superior to poor readers in "knowing what they know" (Brown, 1975).

In addition, the similarity in performance of the good and poor readers with low prior knowledge indicates the importance of word recognition skills. When the ease of word recognition is equalized between the two groups of readers and the level of prior knowledge is low, poor readers can answer questions as well as good readers.

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Figure 1. Ability X Level of Prior Knowledge Interaction for Mean Total Comprehension Scores.

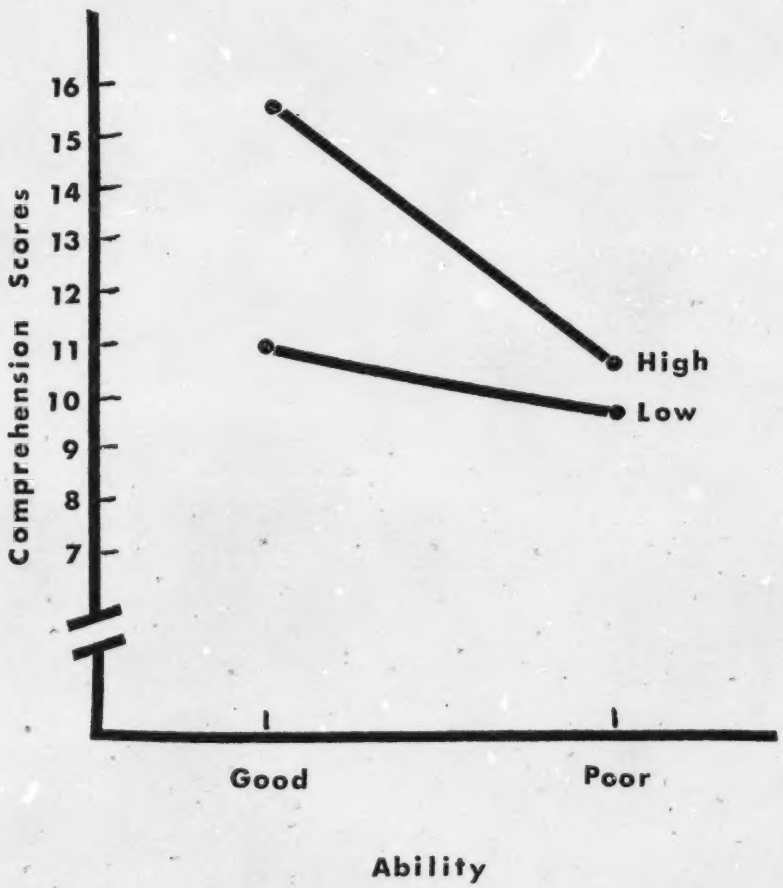


Figure 2. Ability X State of Prior Knowledge Interaction for Percent Correct Comprehension.

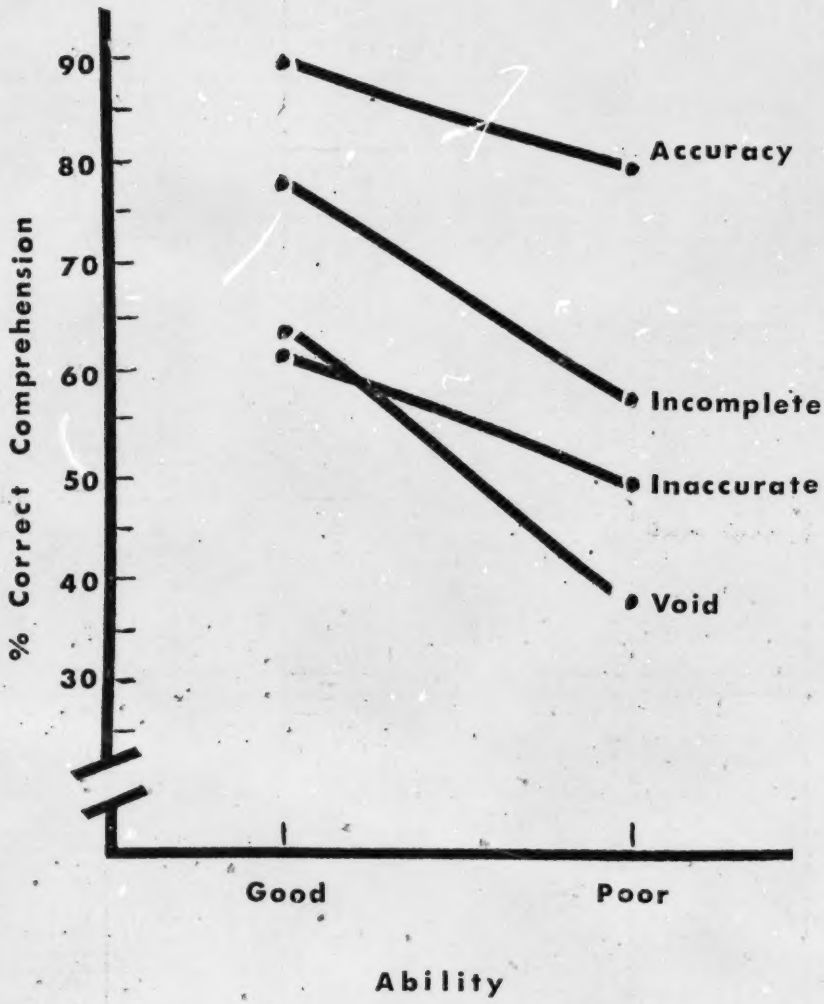


Figure 3. Ability X Level of Prior Knowledge in the Accurate State.

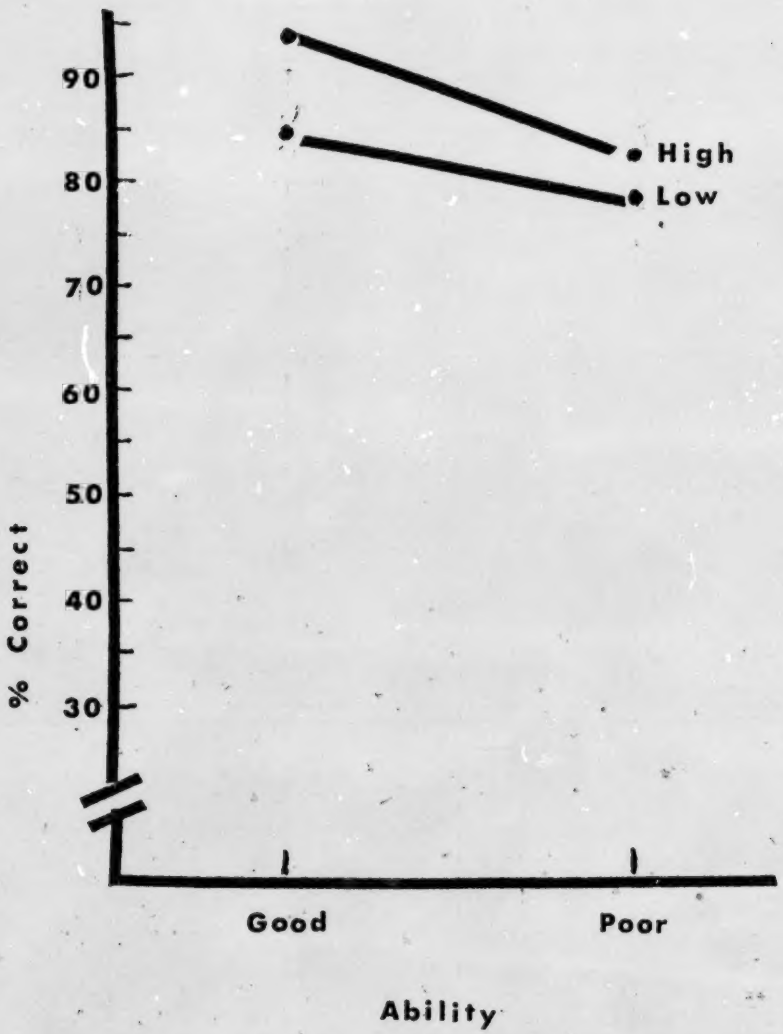


Figure 4. Ability X Level of Prior Knowledge in the Inaccurate State.

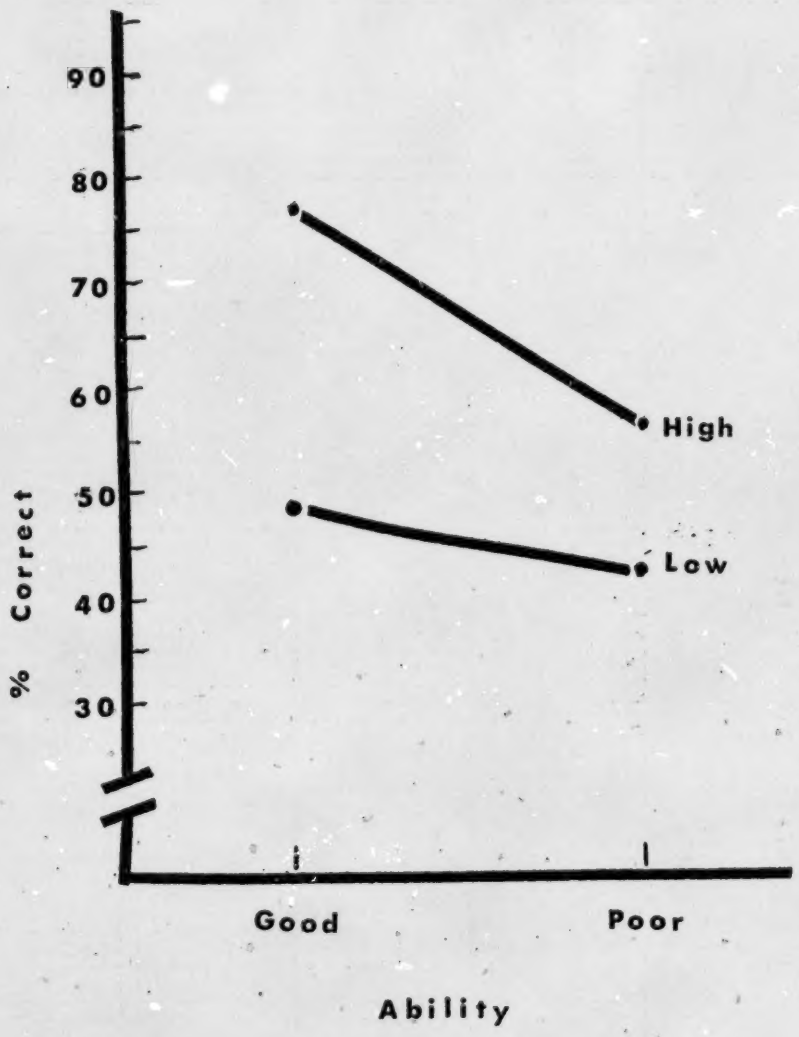


Figure 5. Ability X Level of Prior Knowledge in the Incomplete State.

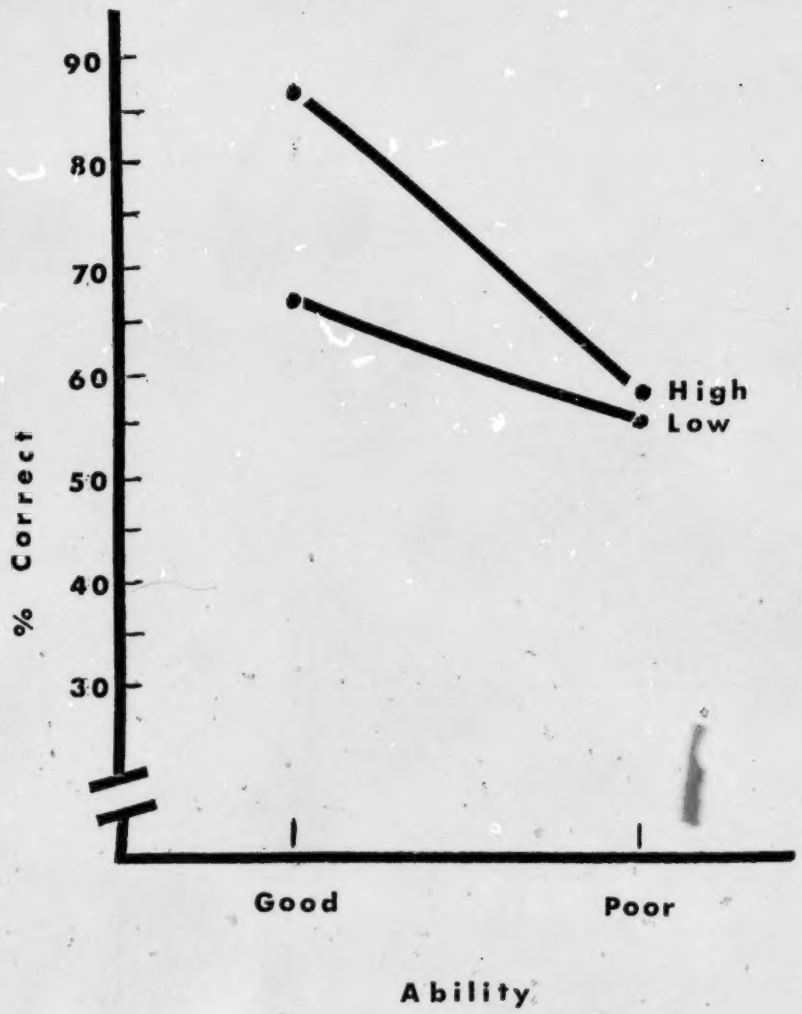


Figure 6. Ability X Level of Prior Knowledge in the Void State.

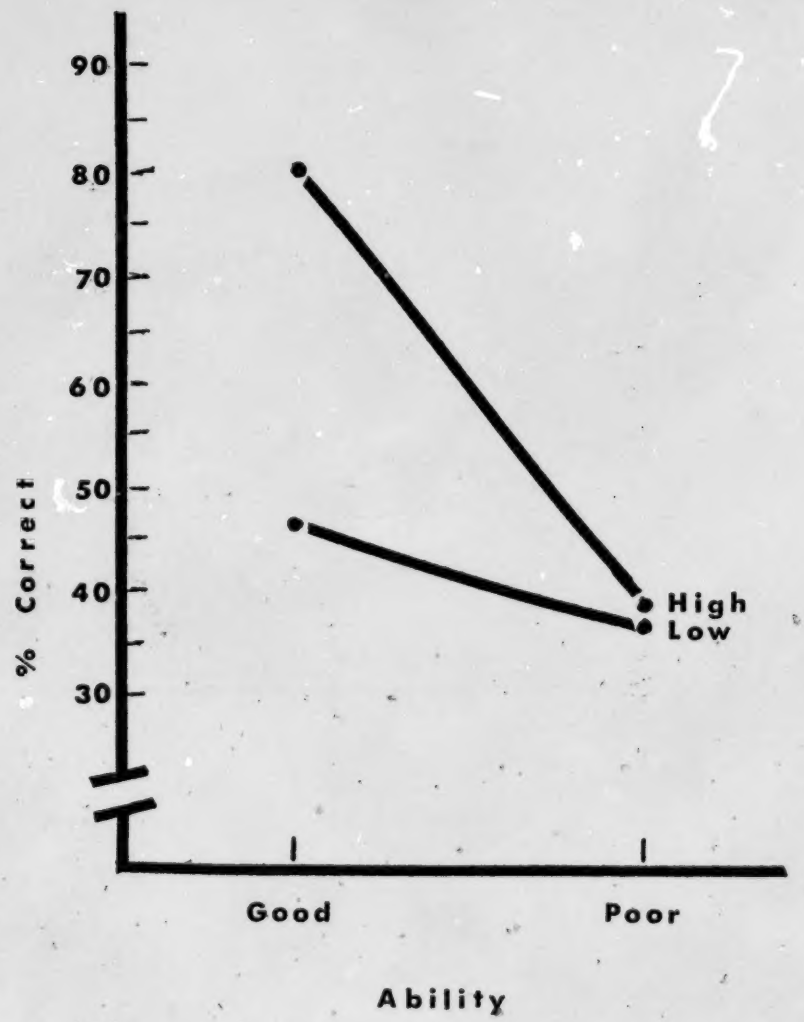


Figure 7. Ability X Question Type for Percent Correct Comprehension.

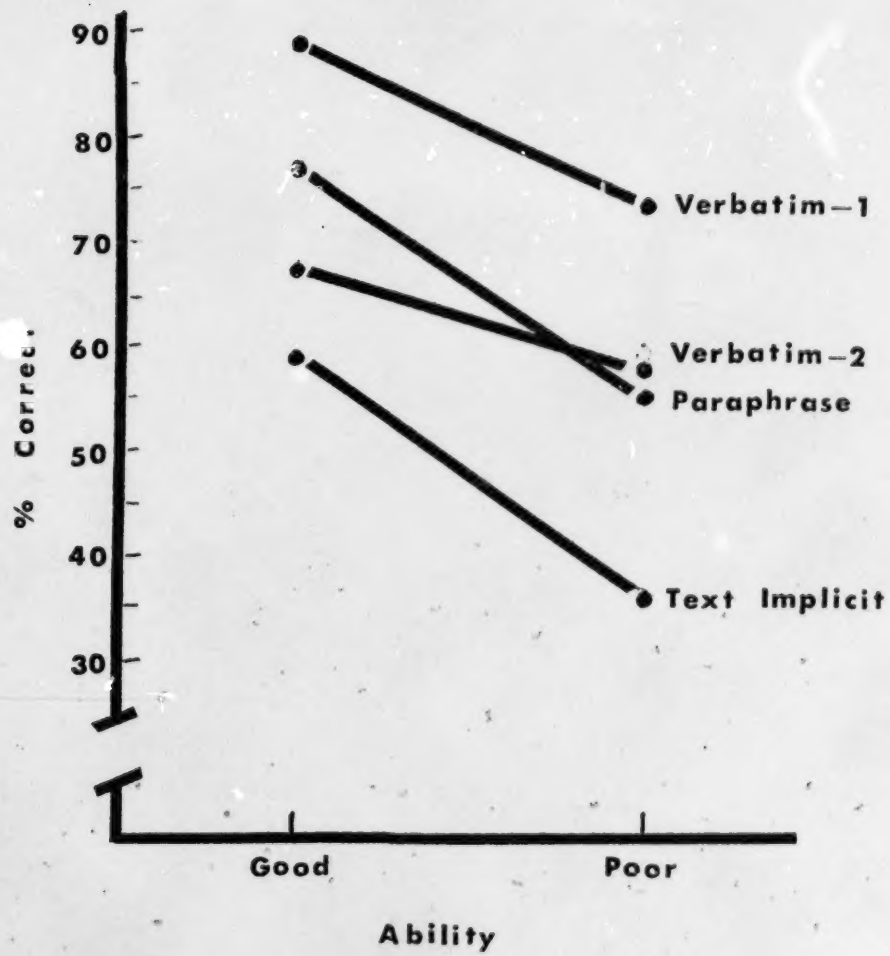


Figure 8. Ability X Question Type in the Accurate State.

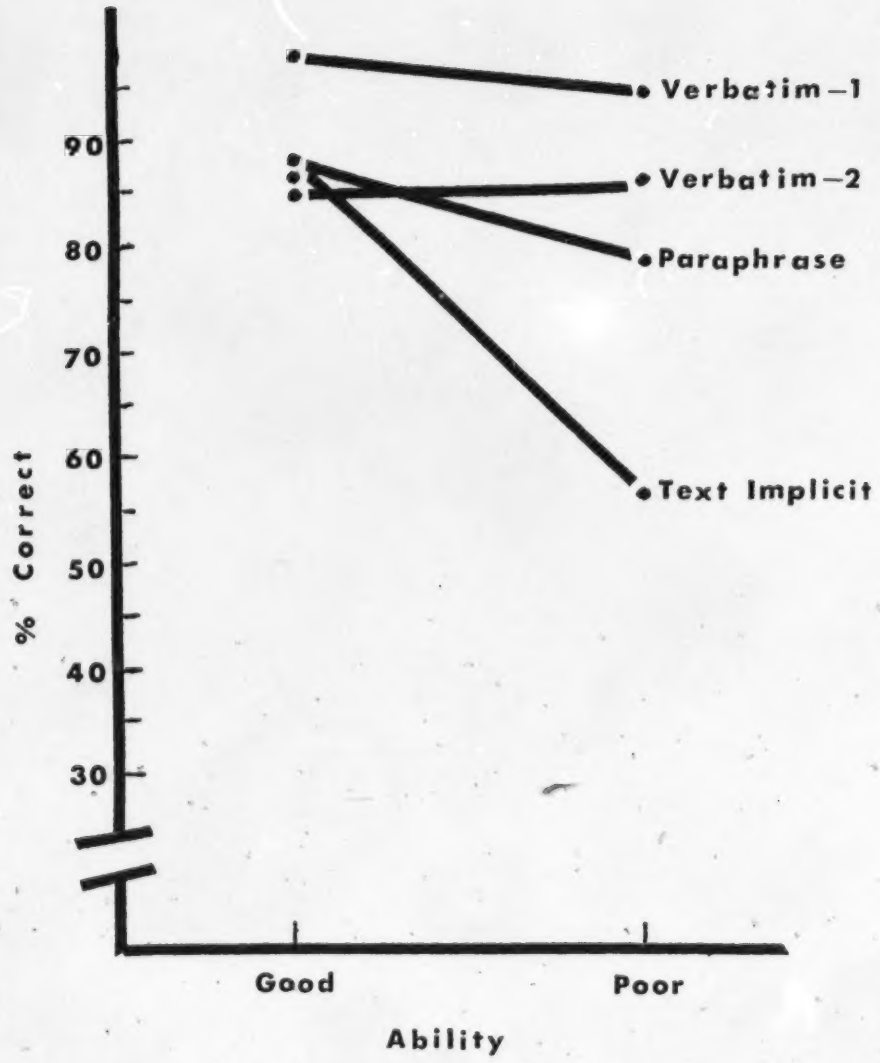


Figure 9. Ability X Question Type in the Inaccurate State.

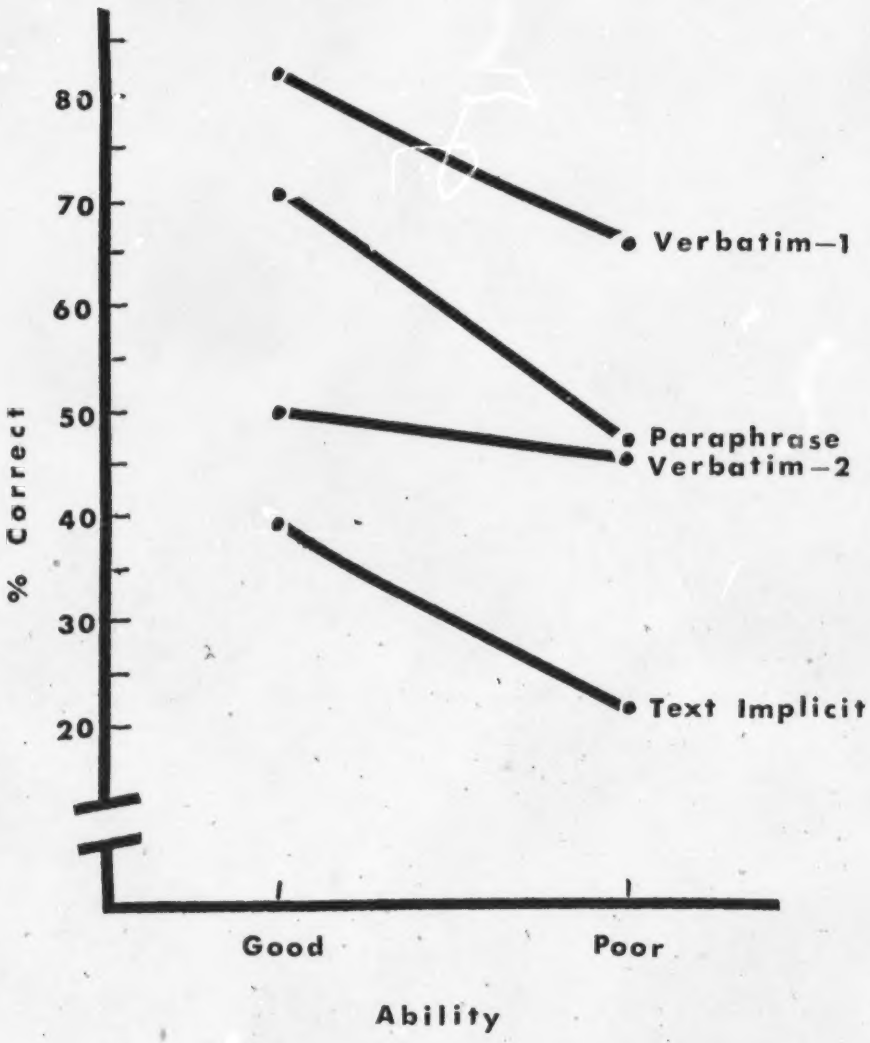


Figure 10. Ability X Question Type in the Incomplete State.

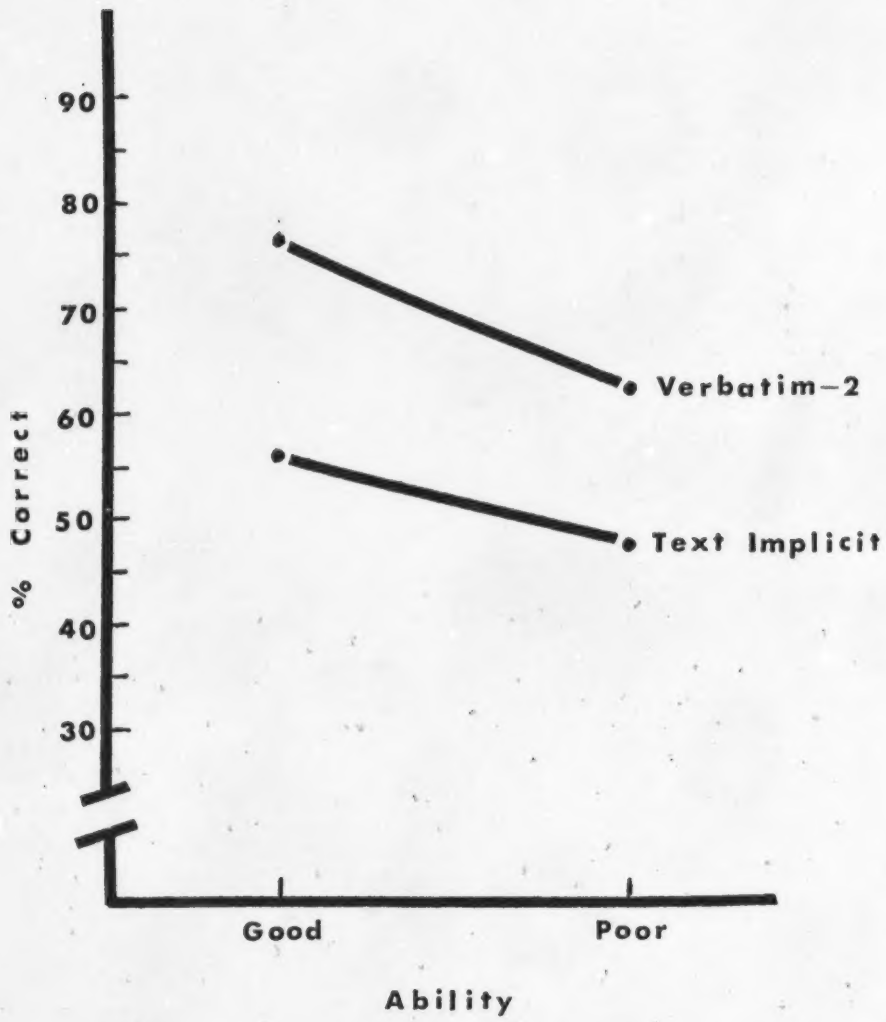
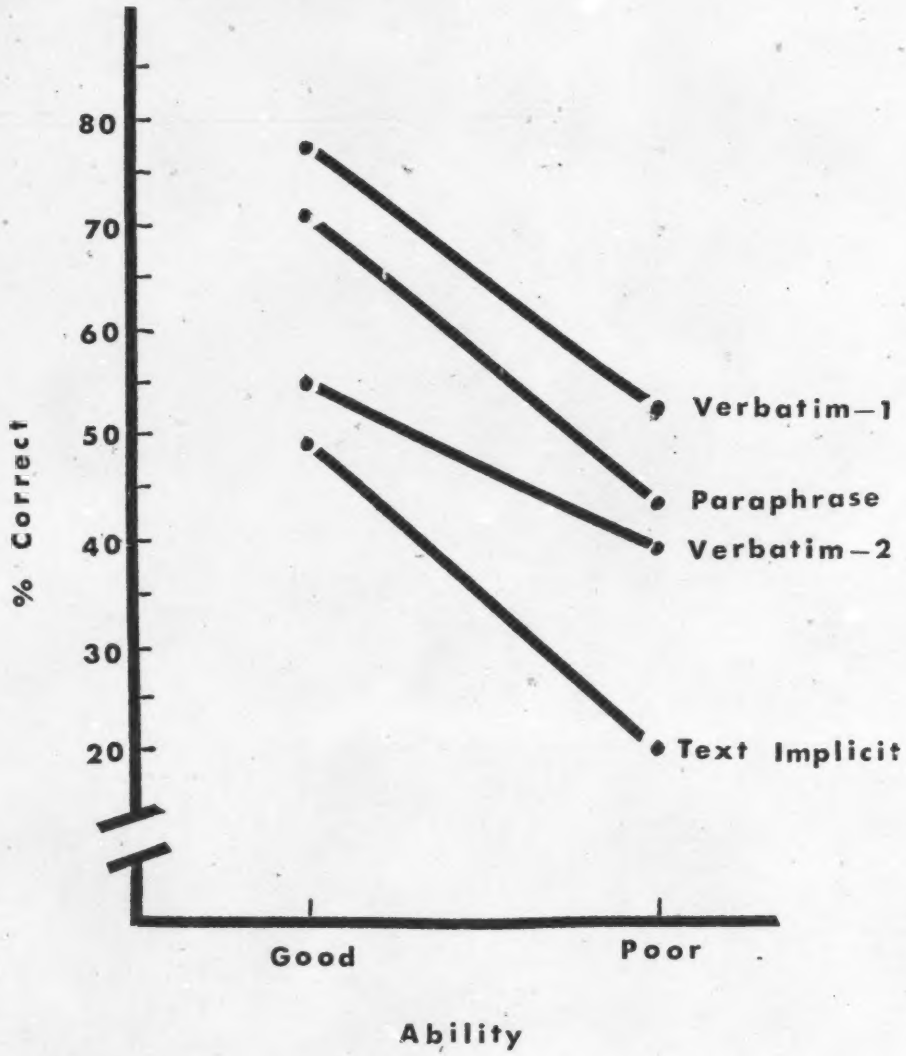


Figure 11. Ability X Question Type in the Void State.



Mean Comprehension Scores for the States of Prior Knowledge

Groups	States			
	Accurate	Inaccurate	Incomplete	Void
Good, High P.K.	21.3	9.0	10.71	21.43
Poor, High P.K.	17.5	6.36	5.71	14.29
Good, Low P.K.	11.86	5.93	4.86	19.7
Poor, Low P.K.	10.36	7.43	5.29	16.21

SAMPLE PARAGRAPHS

SHARK PASSAGE (3.0 LEVEL)

1. SHARKS ARE IN THE CLASS OF ANIMALS CALLED FISH. THEY ARE LIKE OTHER FISH IN THAT THEY HAVE A BACKBONE, BREATHE WITH GILLS, AND ARE COLD-BLOODED. THERE ARE ABOUT 250 KINDS OF SHARKS. ONLY 35 KINDS WILL HURT MAN. THE BIGGEST SHARK GROWS TO BE 50 FEET LONG. ONE KIND GROWS TO BE ONLY FIVE INCHES LONG. SHARKS LIVE IN ALL THE OCEANS OF THE WORLD. THEY LIKE WARM WATERS THE BEST.

SHARK PASSAGE (6.0 LEVEL)

1. SHARKS ARE IN THE CLASS OF ANIMALS KNOWN AS FISH. THEY ARE SIMILAR TO OTHER FISH IN THAT THEY POSSESS A BACKBONE, BREATHE WITH GILLS, AND ARE COLD-BLOODED. THERE ARE APPROXIMATELY 250 SPECIES OF SHARKS. ONLY 35 SPECIES ARE POTENTIALLY DANGEROUS TO MAN. THE LARGEST SHARK MEASURES 50 FEET IN LENGTH. ONE SPECIES MATURES TO A LENGTH OF ONLY FIVE INCHES. SHARKS INHABIT ALL THE OCEANS OF THE WORLD. THEY THRIVE BEST IN WARM WATERS.

SAMPLE COMPREHENSION QUESTIONS

FOR THE 6.0 PASSAGES, THE WORDS IN PARENTHESES WERE SUBSTITUTED FOR THE UNDERLINED WORDS.

PARAGRAPH 1

1. IN WHAT CLASS OF ANIMALS ARE SHARKS? (ONE-IDEA VERBATIM)

2. WHAT SIZE IS THE SMALLEST ADULT SHARK? (ONE-IDEA PARAPHRASE)

3. HOW ARE SHARKS LIKE (SIMILAR TO) OTHER FISH? (TWO-IDEAS VERBATIM)

4. ARE MOST SHARKS DANGEROUS TO MAN? (TEXT IMPLICIT)